



Fig. 1

## BACKGROUND ART

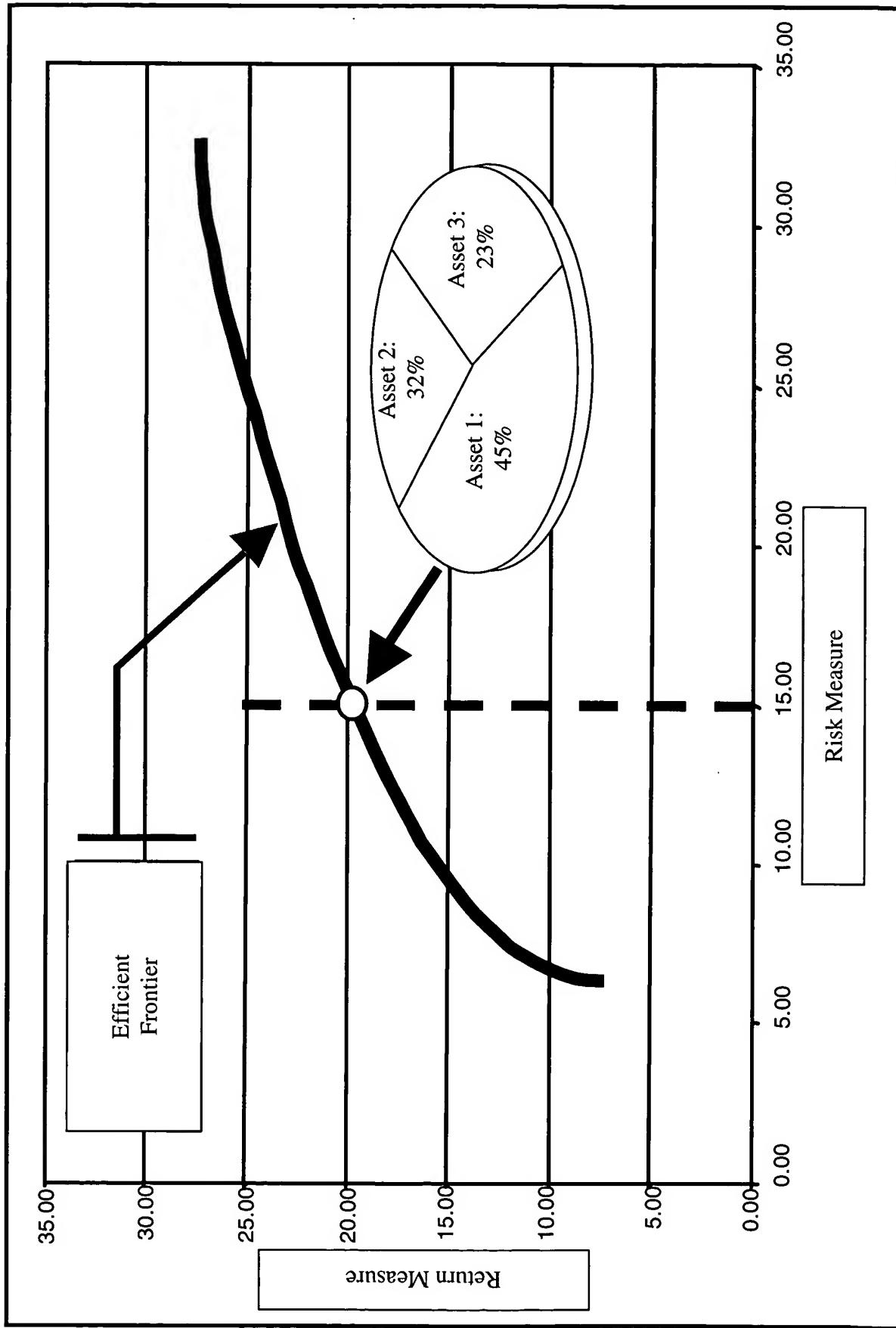


Fig. 4

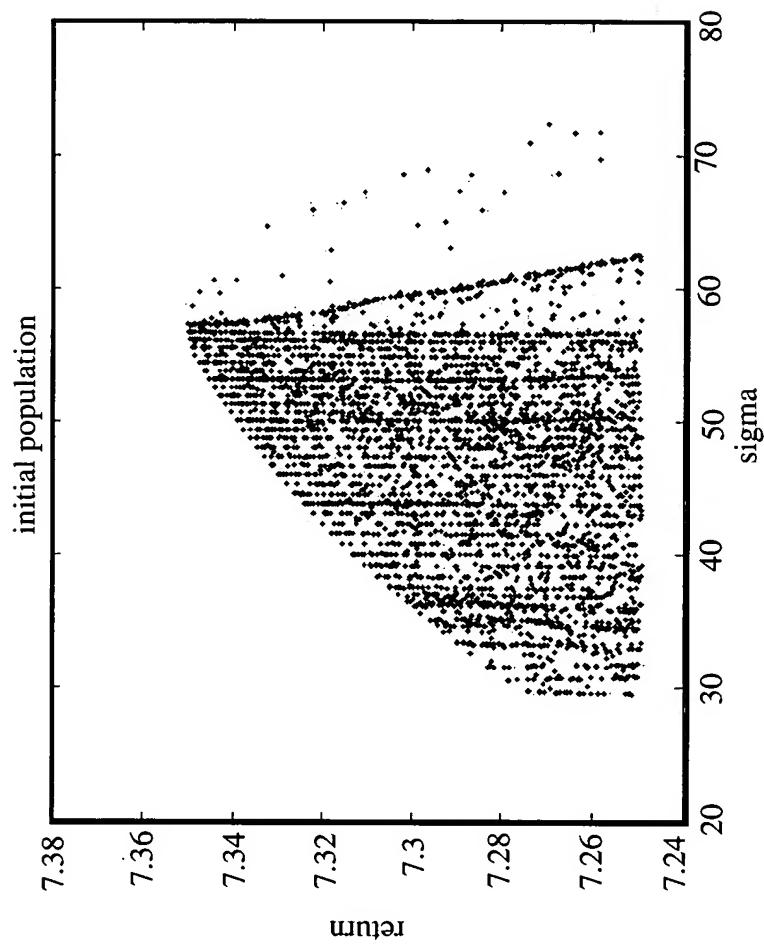
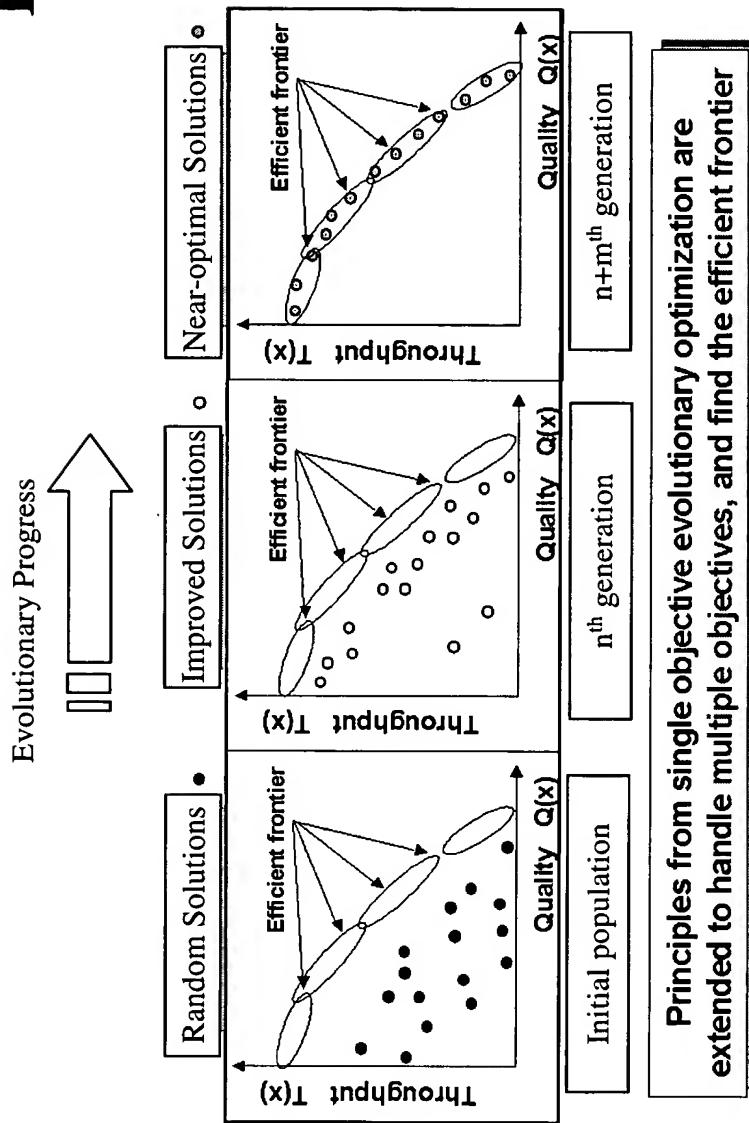
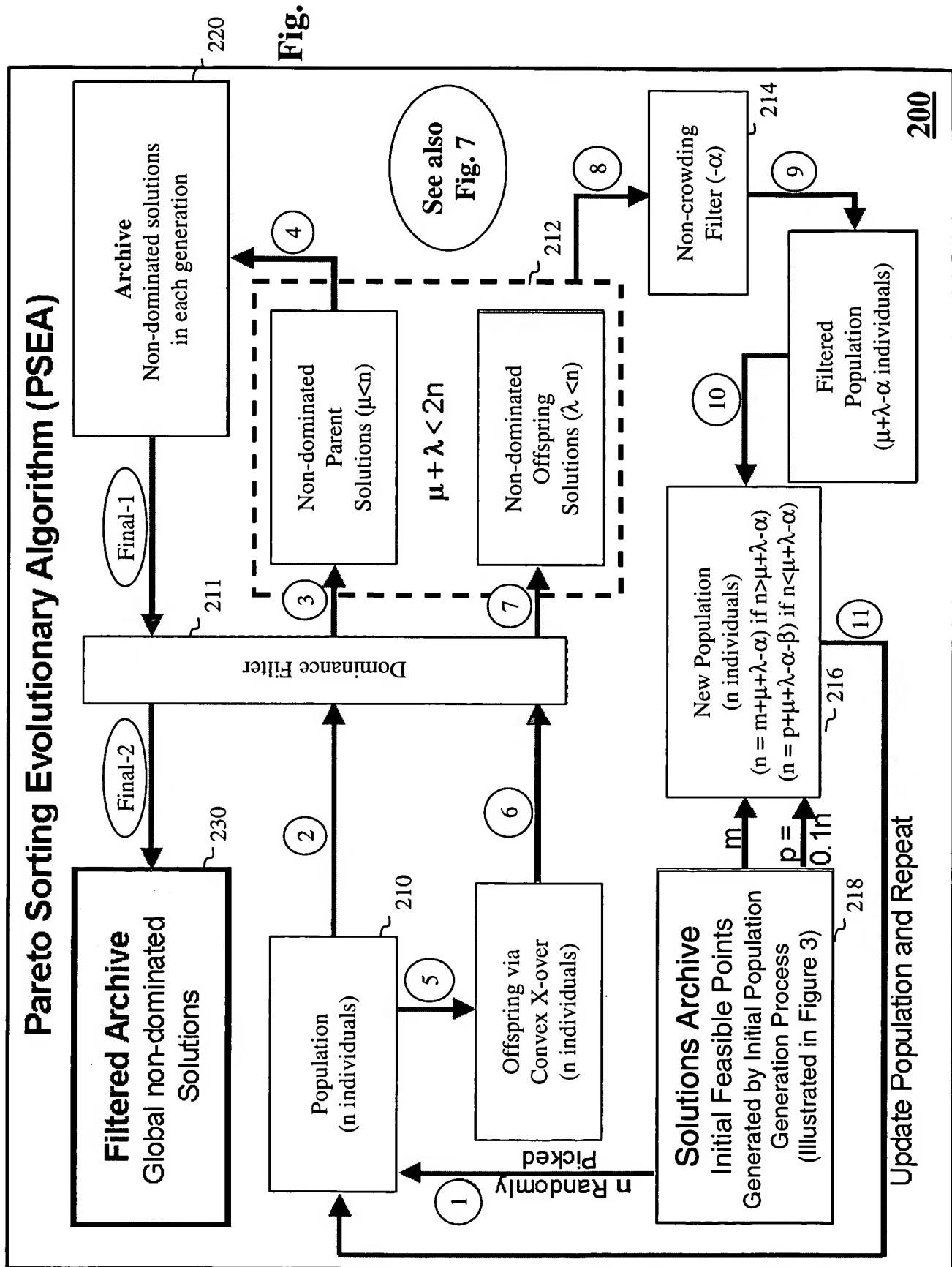


Fig. 5



**Principles from single objective evolutionary optimization are extended to handle multiple objectives, and find the efficient frontier**

Pareto Sorting Evolutionary Algorithm (PSEA)



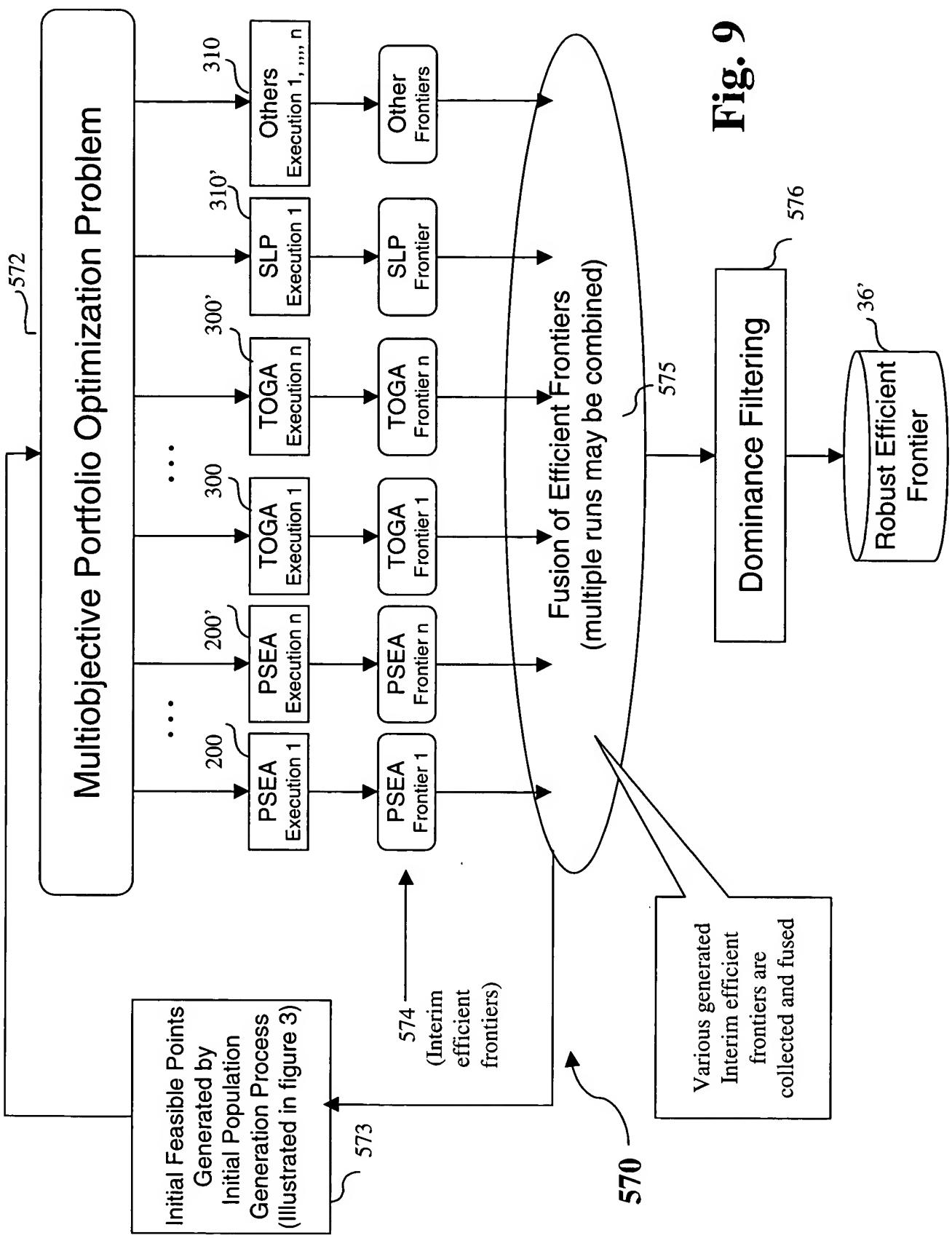
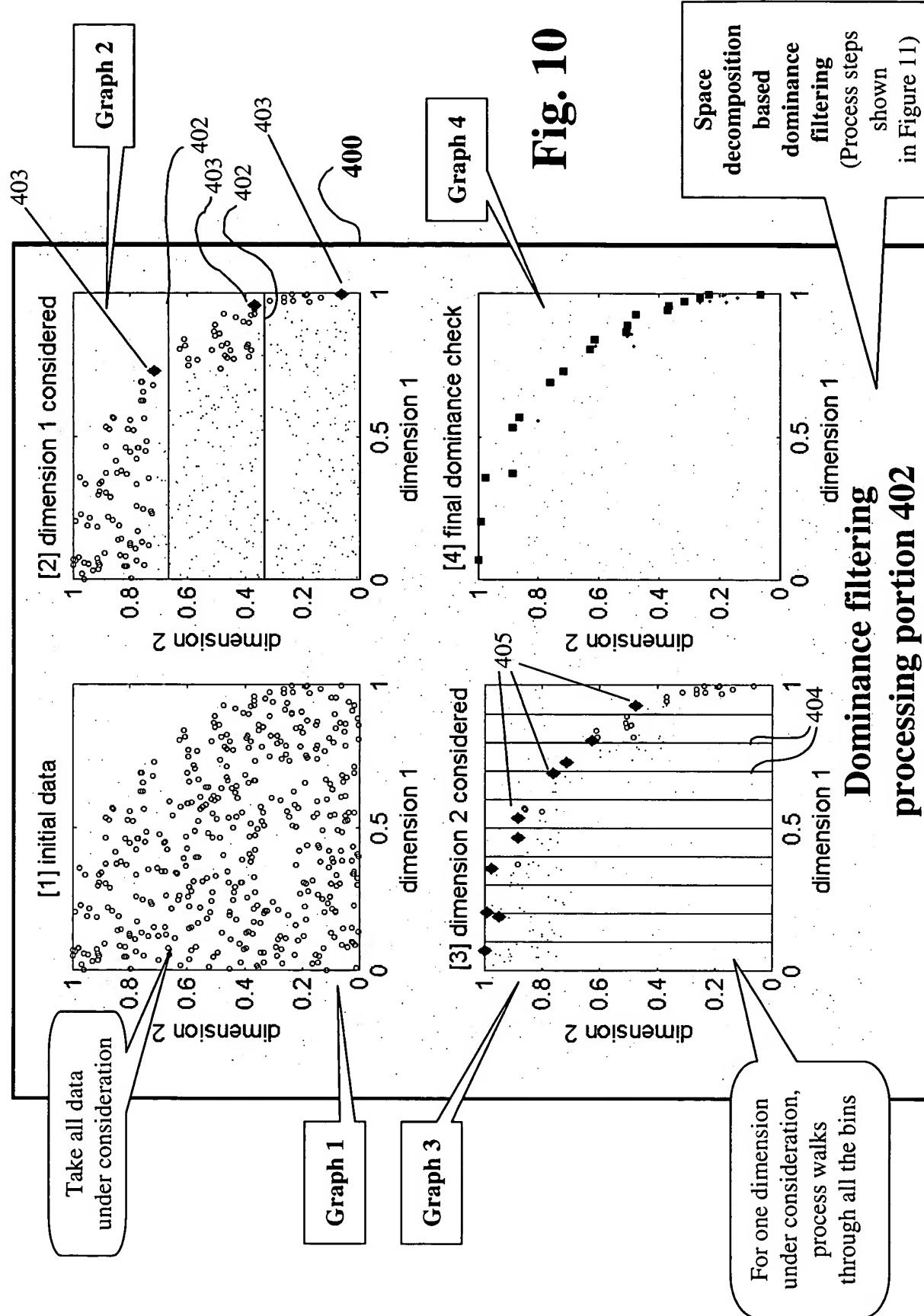
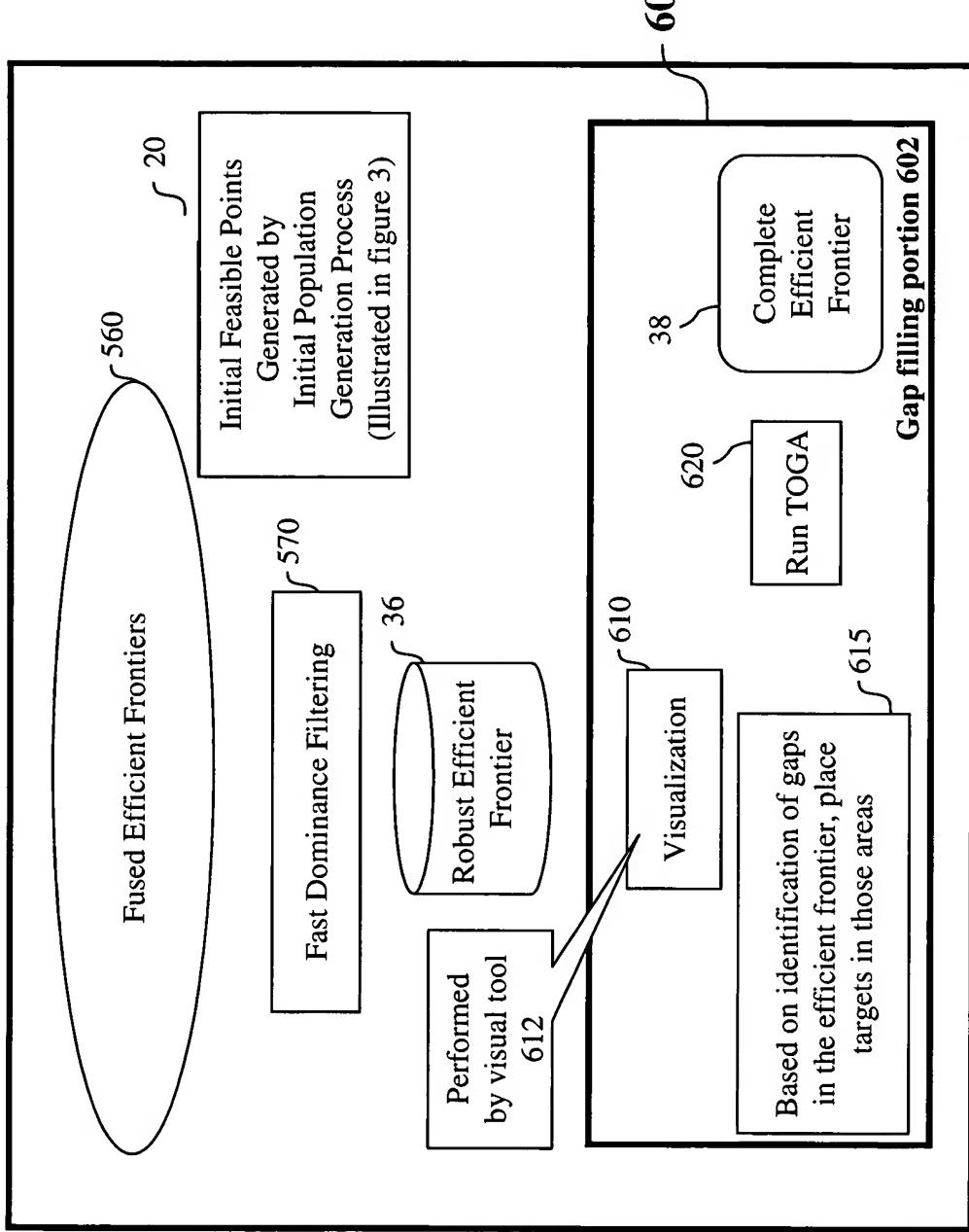


Fig. 9



**Fig. 12**



**Process to interactively fill any gaps in the identified efficient frontier**

## BEST AVAILABLE COPY

EXAMPLE OF PARALLEL COORDINATE PLOT

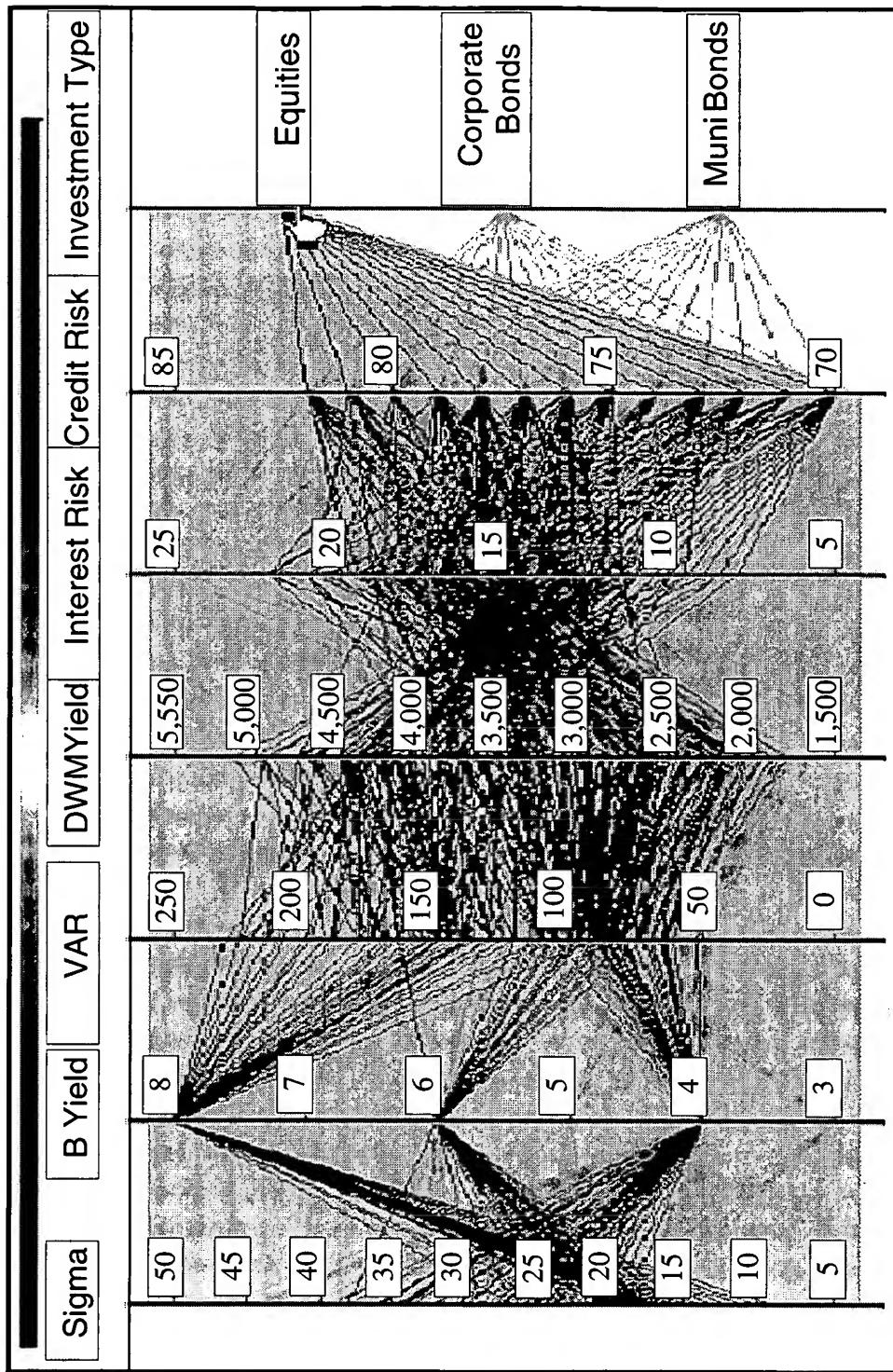
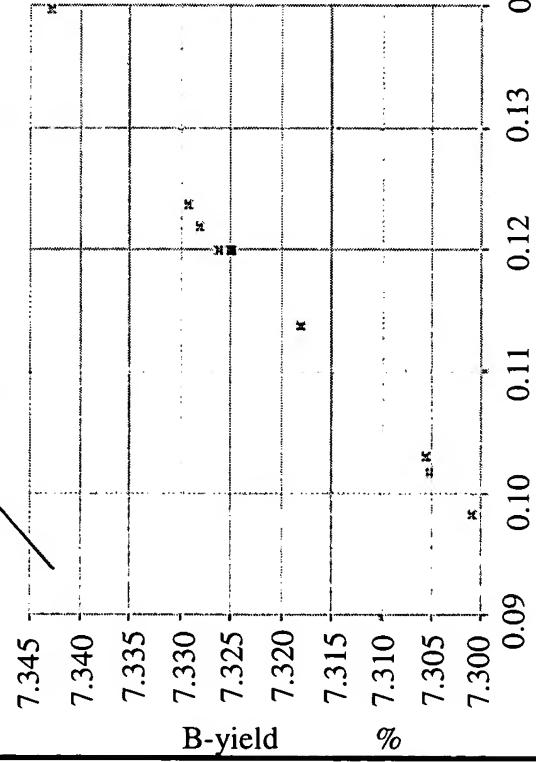
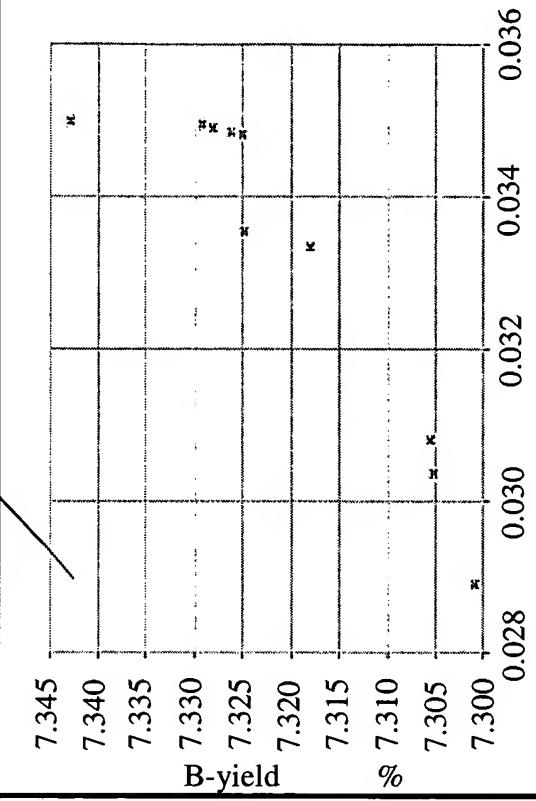


Fig. 14

812



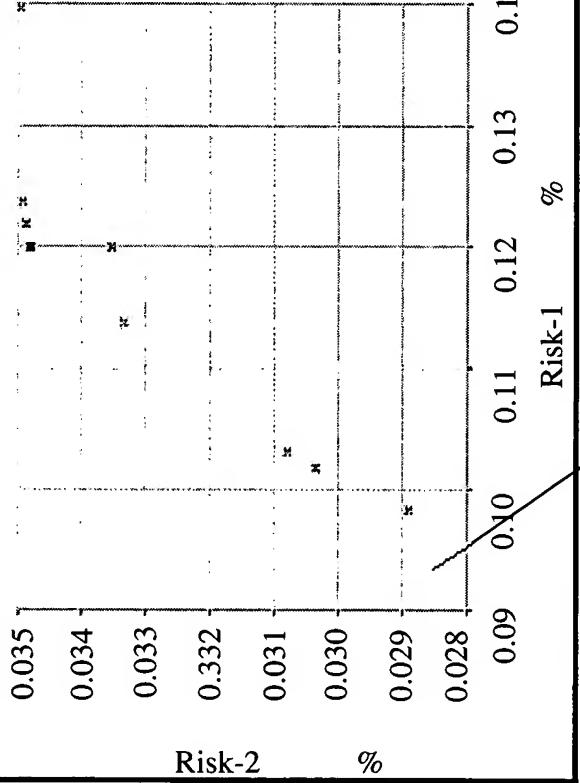
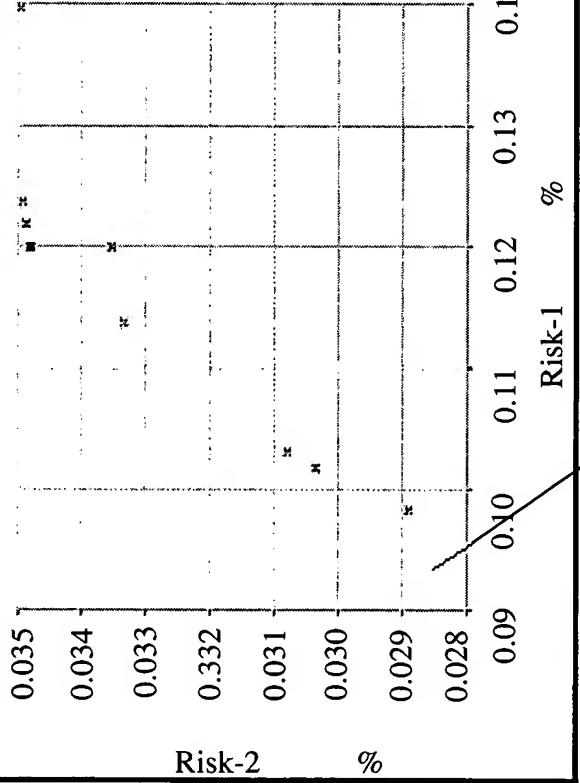
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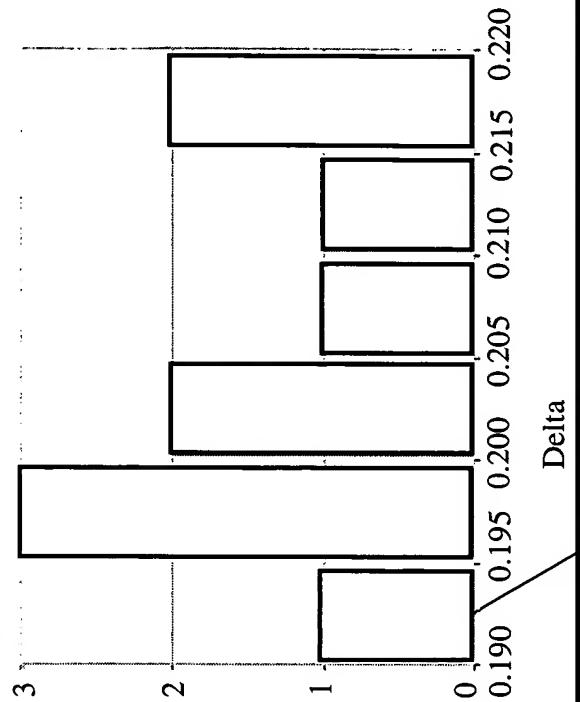
Risk-1 %

Risk-2 %

B-yield



Number of occurrences



816

819

**Fig. 22**

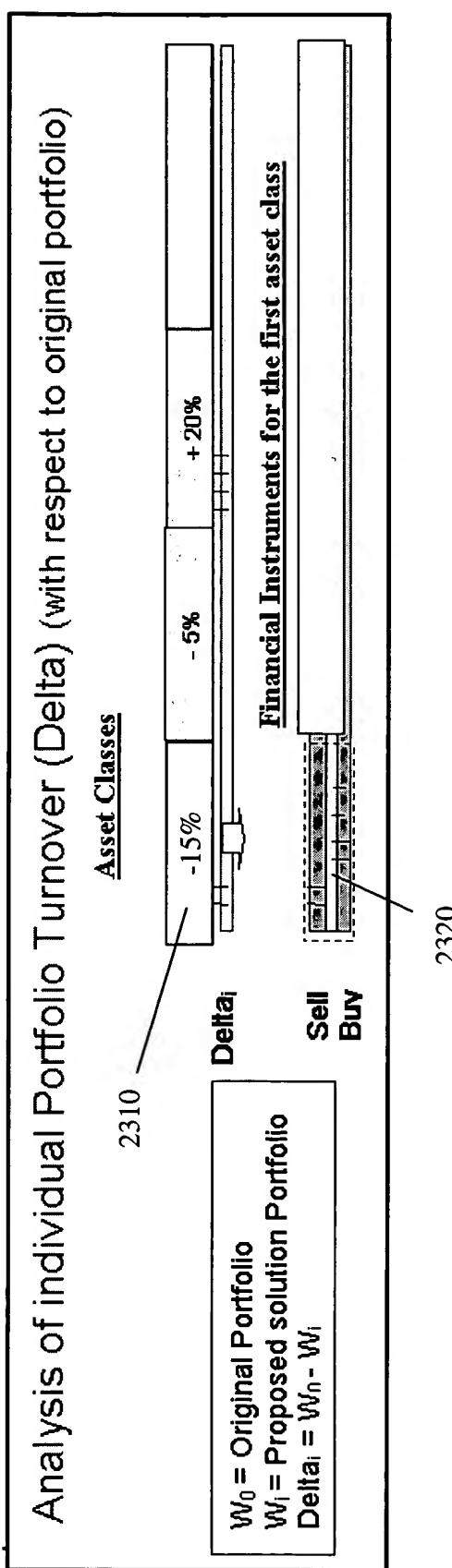
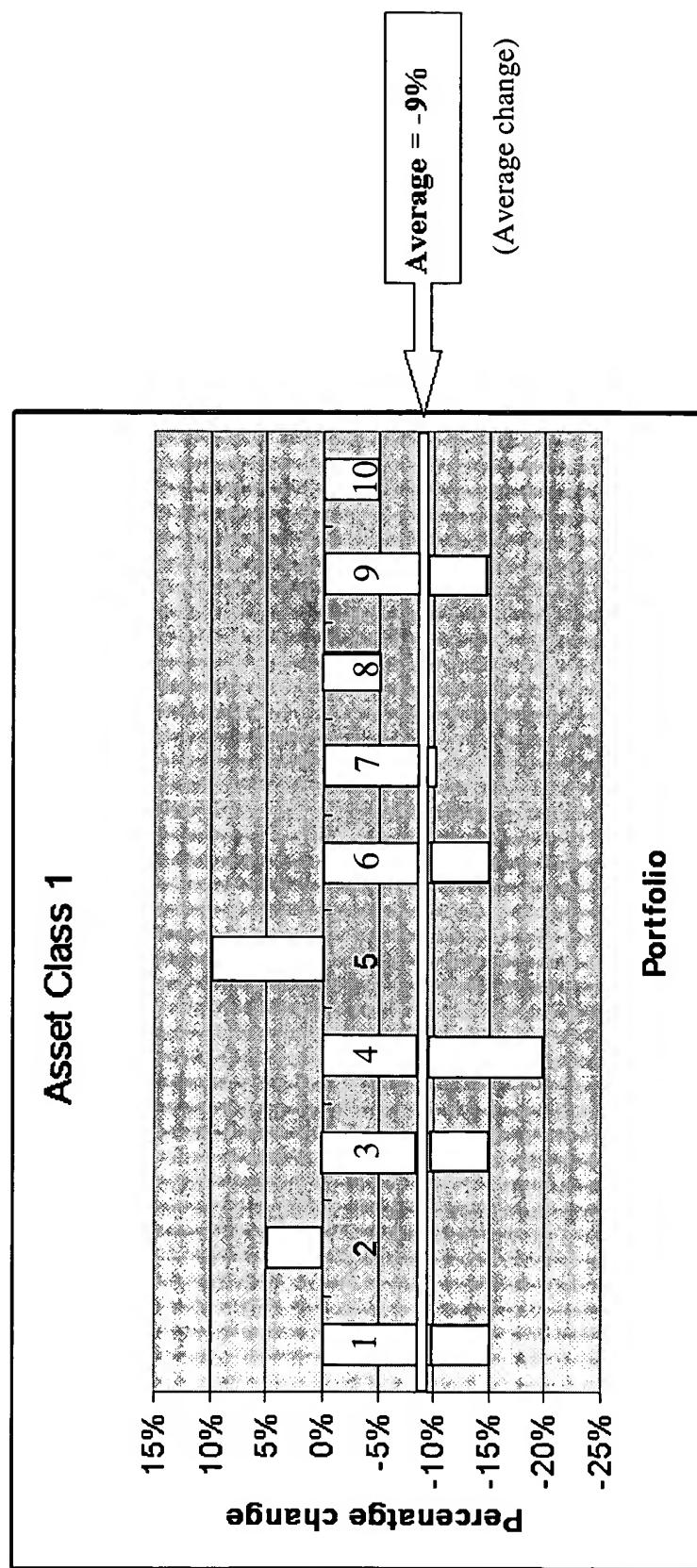


Fig. 23



**Fig. 26**

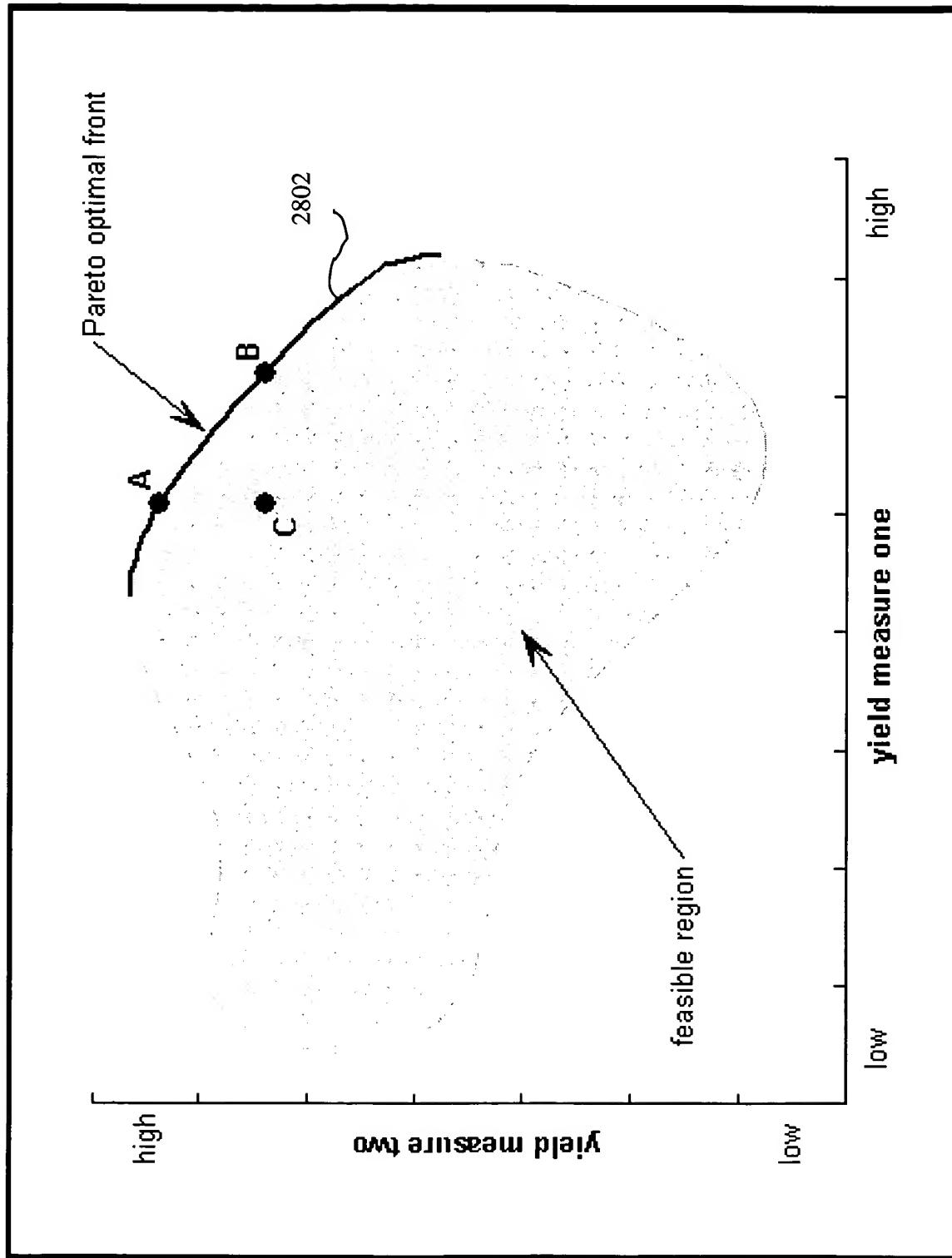
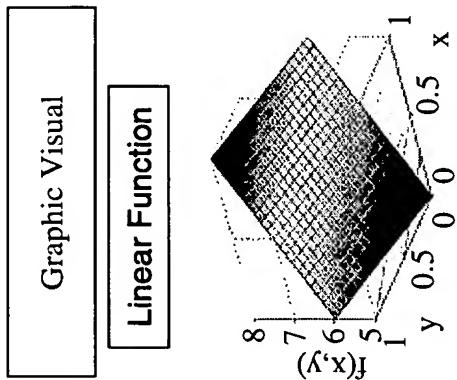
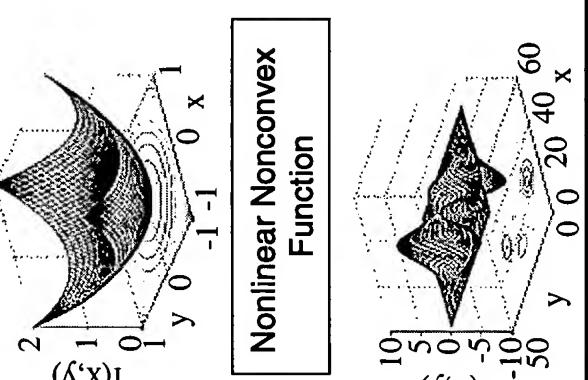


Fig. 28

Figure 34

Objective Functions

Graphic Visual	Word Description	Example Equation	GEAM
	<ul style="list-style-type: none"> <li>Function is defined using linear equations</li> <li>Straightforward math relationship</li> <li>Easy to optimize</li> </ul>	$f(x, y) = 2x + y + 5$	<ul style="list-style-type: none"> <li>Market value weighted yield</li> <li>Duration weighted yield</li> </ul>
	<ul style="list-style-type: none"> <li>Function is defined using a nonlinear equation</li> <li>Functional gradients lead to single optimum</li> <li>Harder to optimize</li> </ul>	$f(x, y) = x^2 + y^2$	<ul style="list-style-type: none"> <li>Interest rate sigma</li> </ul>
	<ul style="list-style-type: none"> <li>Function is defined using complex nonlinear equations</li> <li>Multiple local optima</li> <li>Functional gradients are inefficient</li> <li>Very hard to optimize</li> </ul>	$f(x, y) = g_1(x, y) + g_2(x, y) + g_3(x, y) + g_4(x, y)$	<ul style="list-style-type: none"> <li>Interest rate sigma and VAR</li> </ul>